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WATER QUALITY CONTROL STUDY, MEDICINE LODGE RIVER BASIN, KANSAS, OKLAHOMA: STUDY OF NEEDS AND VALUE OF STORAGE FOR WATER QUALITY CONTROL

Public Health Service
Dallas, Texas

July 1965

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WATER QUALITY CONTROL STUDY
MEDICINE LODGE RIVER BASIN
KANSAS, OKLAHOMA

Study of Needs and Value of Storage for Water Quality Control

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JULY 1965

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WATER QUALITY CONTROL STUDY

MEDICINE LODGE RIVER BASIN

KANSAS, OKLAHOMA

Abstract

A survey has been made of the future need for storage for streamflow regulation for the purpose of water quality control. No immediate or future need for water quality control storage is indicated under any of the proposed operating conditions. Projected water needs used in waste flow evaluations were furnished by the Bureau of Reclamation.

Prepared for

U.S. DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

Oklahoma City Development Office--Oklahoma

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service, Region VII
Dallas, Texas

JULY 1965

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I. INTRODUCTION

Request and Authority

In a letter dated August 5, 1964, the Bureau of Reclamation, Oklahoma City Development Office, requested that the Public Health Service review reservoir operation studies for the Barber County project, Kansas (Medicine Lodge River basin) ". . . and furnish a . . . report of the pollution control benefits the project might provide. The report should include any necessary recommendations for low-flow augmentation and the corresponding benefits. Figures should be provided for the Lower Elm Creek Reservoir (Amber Reservoir) operating alone, for the Kiowa Reservoir operating alone, and the two reservoirs operating together."

This study has been made in accordance with the above request and Section 2(b) of the Federal Water Pollution Control Act as amended (33 U.S.C. 466a(b)).

Purpose and Scope

The purpose of this study is to estimate water requirements for water quality control purposes to the year 2020 in the Medicine Lodge River basin which is encompassed in the six-county study area; Kiowa, Pratt, Comanche, and Barber Counties in Kansas, and Woods and Alfalfa Counties in Oklahoma. Estimates are also to be made of the value of benefits attributable to storage and release of water for this purpose in Kiowa and Amber Reservoirs, proposed Federal projects.

Acknowledgments

The assistance and cooperation of many persons and agencies are gratefully acknowledged. Appreciation is especially expressed to the following:

Kansas State Department of Health, Topeka, Kansas
Kansas Water Resources Board, Topeka, Kansas
Oklahoma State Department of Health, Oklahoma City, Oklahoma
Oklahoma Water Resources Board, Oklahoma City, Oklahoma
Bureau of Reclamation, Oklahoma City, Oklahoma
Officials of communities in the project area

II. SUMMARY OF FINDINGS AND CONCLUSIONS

Summary of Findings

1. The Bureau of Reclamation study proposes construction of Kiowa and Amber Reservoirs, multipurpose projects, to be located in the Medicine Lodge River basin in Barber County, Kansas. Kiowa Reservoir will be located on the main stem of the river about 10 miles above Kiowa, Kansas, while Amber Reservoir will be located about 6 miles up the Elm Creek tributary.

2. Water from storage in the proposed reservoirs will be available for use throughout the Medicine Lodge watershed and adjoining areas.

3. Principal communities in the project area include: Pratt, Greensburg, Coldwater, Medicine Lodge, and Kiowa, Kansas; and Alva, Waynoka and Cherokee, Oklahoma.

4. Major water users and waste producers discharging to the Medicine Lodge River in 1962 included the towns of Medicine Lodge and Kiowa, Kansas. The combined population equivalent (P.E.) [a/] of treated wastes from the two communities averages about 1,100. Secondary treatment is provided at both towns.

5. Total municipal water use by principal communities in the project area was 4.7 million gallons per day (mgd) or about 173 gallons per capita per day (gpcd) in 1960. Reported water use by communities in the Medicine Lodge watershed was 0.85 mgd.

6. Based on limited chemical quality data, water to be impounded in Amber Reservoir appears to be of good chemical quality, suitable for municipal and industrial purposes. Water in the main stem of the Medicine Lodge River (that which would be impounded in Kiowa Reservoir) contains undesirable levels of dissolved minerals, particularly sulfates. With construction of Kiowa Reservoir, it is expected that

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[a/] The calculated population which would normally contribute the same amount of biochemical oxygen demand (BOD) per day.

this water will be of marginal quality, exceeding upper limits of the Public Health Service Drinking Water Standards-1962 for finished waters most of the time.

7. Projections by the Bureau of Reclamation indicate: (1) The total population of principal communities (Kiowa and Medicine Lodge) in the Medicine Lodge watershed will reach 8,320 by the year 2020. (2) Municipal water needs for the above towns will be 1.2 mgd by the year 2020.

Conclusions

1. The expected natural streamflow occurring in the Medicine Lodge River below confluence with Elm Creek is more than adequate to assimilate adequately treated waste discharges from both Medicine Lodge and Kiowa (located about 20 miles downstream) throughout the year even at the 50-year drought recurrence interval.

2. Based on information presently available, there is no discernible need for storage of water in study projects for purposes of water quality control in the Medicine Lodge River.

3. If Kiowa Reservoir is constructed, adequately treated waste flows from Medicine Lodge can be assimilated by the reservoir. Expected seepage losses from the reservoir, estimated at 5 cubic feet per second (cfs), will be more than adequate to assimilate treated waste discharges from Kiowa. Without these seepage losses, streamflow below the town of Kiowa will be polluted.

4. In the absence of Kiowa Reservoir and with Amber in operation, the expected natural runoff of the Medicine Lodge River above confluence with Elm Creek appears sufficient to assimilate treated waste flows from Medicine Lodge and Kiowa through the year 2020.

5. If measures are undertaken to substantially reduce mineral pollution from the Salt Fork as part of the objective of the Arkansas-Red River Basins Water Quality Project, the dissolved mineral contribution from the Medicine Lodge tributary will become more significant and may require further study.

III. PROJECT DESCRIPTION

The Barber County project of the Bureau of Reclamation would involve construction of either one or two multipurpose reservoirs in the Medicine Lodge River basin.

Location and Principal Features

Amber Reservoir

The Amber Reservoir will be located approximately 5 miles above the town of Medicine Lodge on Elm Creek, a tributary to the Medicine Lodge River in Barber County, Kansas. (See figure III-1 following page IX-1.)

Tentative plans by the Bureau of Reclamation are for a multipurpose reservoir with storage of 22,000 acre-feet for flood control, 49,270 acre-feet for municipal and industrial water requirements, and 5,500 acre-feet for fish and wildlife purposes. The conservation pool will have a dependable yield of approximately 5.1 mgd and will be used to meet municipal and industrial water requirements in and near Barber County.

Kiowa Reservoir

Kiowa Reservoir will be located on the main stem of the Medicine Lodge River about 10 miles above the town of Kiowa in Barber County, Kansas. Since the Amber damsite is located only a short distance above the planned Kiowa project, consideration is being given to operation of Kiowa Reservoir with and without Amber in place.

The reservoir will be a multipurpose project. If Amber Reservoir is constructed, conservation storage in Kiowa will be used for irrigation purposes below the town of Kiowa. It is expected that approximately 8,500 acres of land could be irrigated by water supplied from the reservoir. Storage allocations in Kiowa with the two reservoirs operating together would include: flood control - 83,902 acre-feet, conservation - 162,763 acre-feet, and fish and wildlife - 9,952 acre-feet.

Tentative plans are for a larger reservoir at the proposed Kiowa damsite if Amber Reservoir is not constructed. Storage would be increased to 125,506 acre-feet for flood control, 195,244 acre-feet for conservation uses, and 9,986 acre-feet for fish and wildlife purposes. The additional storage would include water for irrigating an additional 1,500 acres in Barber and Alfalfa Counties.

Streamflow

As indicated in studies of daily flows at Kiowa, Kansas, a greater part of the streamflow in the Medicine Lodge River and its tributaries is surface runoff, with little contribution from ground water. 1/ The smaller streams in this area are typical prairie streams with shallow valleys, low banks, and sand-filled channels which are dry part of the year. The channel of the Medicine Lodge River in its lower reach is relatively wide (300 to 400 feet) and sand-choked, with banks 4 to 5 feet high. Stream velocities are moderately fast during periods of high flow but become negligible for short periods of time during some years. Over the past 18 years a/ discharge at Kiowa has averaged 150 cubic feet per second (cfs).

Estimated natural annual discharges in the Medicine Lodge River (after depletions due to Soil Conservation Service projects) were furnished by the Bureau of Reclamation for points on the river below the confluence with Elm Creek and at Kiowa. 2/ These data were used in evaluating the need for streamflow regulation by study projects as discussed in the appendix.

The Bureau of Reclamation further provided data on irrigation releases from Kiowa Reservoir and spills from both reservoirs under proposed operation for a 41-year period of streamflow ending in 1962. Proposed mean monthly irrigation releases from the Kiowa project based on these data are shown in table III-1. The proposed methods of operation will result in little, if any, spill from the two reservoirs during most years. However, seepage losses on the order of 1.7 cfs and 5.0 cfs are expected to occur at the Amber and Kiowa damsites, respectively. These data were used as one of the bases for this study.

Water Quality

Concentrations of dissolved solids and sulfates in the Medicine Lodge River, as measured by samples taken at Kiowa, Kansas, exceed the upper limits of the Public Health Service Drinking Water Standards-1962. 3/ A summary of analyses of samples taken from the river at Kiowa is shown in table III-2. Impoundment in Kiowa Reservoir will likely provide a substantial improvement in the quality of streamflow due to the equalizing effects of the reservoir. Peak mineral concentrations will be reduced as flows of poor quality are mixed with the higher quality flood flows.

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a/ Discharge records are available for the years 1937-1950, 1954-1955 and 1959-1963.

Table III-1

Proposed Irrigation Releases from Kiowa Reservoir
(mean flow - cfs) a/

Month	With Amber Reservoir in Operation	Without Amber Reservoir in Operation
J	11.6	13.3
F	23.2	27.4
M	44.8	54.1
A	68.1	77.9
M	66.4	74.6
J	50.5	56.6
J	166.0	196.5
A	164.3	194.2
S	84.7	100.3
O	33.0	40.2
N	0	0
D	0	0

a/ Based on the 41-year period of streamflow from 1922 to 1962.

Source: Bureau of Reclamation 2/

Table III-2

Chemical Quality of the Medicine Lodge River
Kiowa, Kansas
(mg/1)

	Dissolved a/ Solids	Chlorides b/	Sulfates b/
Arith. Mean	889	65	271
Maximum	1,825	206	867
Minimum	497	5	5

a/ Period of Record - January 21 - September 14, 1907
March 26 - April 8, 1963
November 18 - December 4, 1963
April 20 - May 25, 1964
October 26 - November 12, 1964

b/ Period of Record - January 21 - September 14, 1907
December 4, 1954 - September 27, 1955
July 28, 1959 - September 27, 1960

Source: Kansas State Board of Health 4/

Water which will be impounded in Amber Reservoir is of much better mineral quality than that in the main stem of the Medicine Lodge. Available quality records, though scarce, indicate lower dissolved solids, chloride and sulfate concentrations. (See table III-3.)

Table III-3

Chemical Quality of Elm Creek at Medicine Lodge, Kansas
(mg/l)

Date of Sample	Dissolved Solids	Chlorides	Sulfates
4/28/48	331	12	38
9/25/63	249	15	31
10/2/63	270	15	31
10/17/63	207	15	29
10/21/63	234	13	23

Source: Bureau of Reclamation 5/

Examination of outcropping gypsum areas in the Medicine Lodge basin shows gypsum deposits to be widespread throughout the western portion of Barber County. These deposits contribute to sulfate pollution in the upper reaches of the Medicine Lodge River, but do not extend into the area of Elm Creek. (See figure III-1.)

IV. STUDY AREA DESCRIPTION

The Medicine Lodge River basin begins in south-central Kansas and extends a short distance into north-central Oklahoma where it is tributary to the Salt Fork of the Arkansas River. (See figure III-1 following page IX-1.) The small drainage basin (less than a hundred miles long) occupies a part of six counties: Kiowa, Comanche, Pratt, and Barber Counties in Kansas and Wood and Alfalfa Counties in Oklahoma. A total area of approximately 1,300 square miles is drained by the watershed.

The area has a dry, subhumid climate with an average annual precipitation varying from 20 to 25 inches. Precipitation is characterized by moderate to intense rainstorms of short duration, with the maximum occurring in the late spring and the minimum during the winter months. The mean annual temperature of the project area is 55°F., with monthly mean temperatures varying from 31°F. in January to 80°F. in July.

Situated in the Great Plains Region, the project area is characterized by red sandy plains and prairie grasslands. The Red Hills area, which covers all but the upper and lower reaches of the basin, is one of rough topography, including irregular escarpments and small canyons, steep bluffs, and buttes. This is one of the most scenic portions of Kansas. The area is primarily suited to pasture, although some of the soils can be cultivated satisfactorily.

In the upper and lower reaches of the basin the topography varies from nearly level to rolling or even rough prairie. Most of it is sufficiently smooth to permit tilling by large size mechanical equipment. Soils in the area are comparatively poor moisture holders, so that in the hot windy summers evaporation is high. Wind erosion is also a troublesome factor for the tilled areas.

Only two communities of over 500 population are located within the Medicine Lodge watershed. These include the towns of Medicine Lodge and Kiowa which had 1960 populations of 3,072 and 1,674 respectively.

Other principal communities lying within the general vicinity of the projects but outside of the watershed include Pratt, Greensburg and Coldwater, Kansas, and Alva, Waynoka, and Cherokee, Oklahoma, whose total populations in 1960 amounted to 21,770.

The economy of the project area is based upon petroleum and natural gas extraction, and ranching and farming. Salt and gypsum are also produced at several locations in the area. Manufacturing is negligible in most of the counties. Principal manufacturing activities are currently directed toward the production of liquid fertilizer,

petroleum, gypsum, and food and kindred products. The Medicine Lodge watershed and adjoining counties are within the Wichita-Hutchinson and Enid trade areas.

V. WATER RESOURCES OF THE PROJECT AREA

There are presently no surface water reservoirs of any significant size or yield in the Medicine Lodge River basin. All of the communities shown on figure III-1 rely on ground water for municipal and industrial water supply purposes.

The occurrence of ground water in this area is largely confined to Kiowa and Pratt Counties and the alluvial plains of the Salt Fork and the Medicine Lodge Rivers. Wells throughout most of Kiowa and the northern portion of Pratt Counties generally yield about 500 gallons per minute (gpm), while those in the southern portion of Pratt County, the northeast section of Comanche County, and the alluvial plains of the two rivers yield from 50-500 gpm. 6 7/ Ground water yield in the project area outside of the locations mentioned above is generally less than 50 gpm.

A summary of existing ground water supplies in the project area is shown in table V-1.

Table V-1

Existing Ground Water Supplies in the Project Area

Municipality Served	No. Wells*	Yield (mgd)
Greensburg	5	1.0e
Pratt	10	6.3e
Coldwater	4	0.9e
Medicine Lodge	--	1.1e
Kiowa	6	0.8e
Waynoka	7	1.45*
Alva	18	3.25*
Cherokee	7	4.50*

e Estimate.

*Source: Public Health Service 8/

As shown by table V-2, chemical quality of these ground water supplies ranges from fair to excellent.

Table V-2

Chemical Analysis - Public Water Supplies of the Project Area
(mg/l)

Substance	City							
	Medicine Lodge	Kiowa	Pratt	Coldwater	Greensburg	Alva	Cherokee	Waynoka
Calcium (Ca)	64	111	63	42	62	44	94	68
Magnesium (Mg)	8.4	40	9.5	6.1	6.2	5.9	19	11
Sodium (Na)	22	95	39	16	17	13	--	28
Bicarbonate (HCO_3)	220	359	207	166	212	165	314	224
Sulfate (SO_4)	33	185	22	8.6	13	11	63	31
Chloride (Cl)	16	99	51	9.0	14	8.0	86	16
Fluroide (F)	0.3	0.3	0.2	1.0	1.0	0.1	--	0.3
Nitrate (NO_3)	3.1	26	19	8.4	10	6.3	4.1	44
Iron (Fe)	0.05	0.06	0.08	.05	0.13	0.02	--	0.00
Dissolved Solids	374	790	308	195	258	197	515	333
Hardness ($CaCO_3$)	194	442	196	130	180	134	312	215

Source: U.S. Geological Survey in cooperation with Oklahoma Planning and Resources Board 9/, and Kansas State Board of Health 10/

VI. WATER REQUIREMENT - MUNICIPAL AND INDUSTRIAL

General

In order to describe future quantities of domestic and industrial sewage and organic waste flows to the Medicine Lodge River and subsequently provide a basis for forecasting streamflow regulation requirements, examination must be made of the characteristics and levels of water use likely to occur in the basin.

Present Water Use

Combined water use for the principal communities in the six-county project area presently averages about 4.7 mgd as shown in table VI-1.

Table VI-1

Municipal Water Use and Water Supply Data

Municipality	Present Average Demand (mgd)	Source*	Dependable Draft (mgd)
Greensburg	0.15	5 deep wells	1.0e
Pratt	2.00	10 deep wells	6.3e
Coldwater	0.17	4 deep wells	0.9e
Medicine Lodge	0.60	Infil gallery & wells	1.1e
Kiowa	0.25	2 deep wells	
		4 shallow wells	0.8e
Waynoka	0.20	7 wells	1.45*
Alva	1.00	18 wells	3.25*
Cherokee	0.30e	7 wells	4.50*
TOTAL	4.67		

e Estimate.

*Source: Public Health Service 8/

No major water-using industries are within the area.

Future Water Use

Projected water needs used to evalute waste discharges to the Medicine Lodge River were furnished by the Bureau of Reclamation.

Water uses from which significant waste discharges to the Medicine Lodge River are expected include that used for municipal water supply purposes in the area of Medicine Lodge and Kiowa and for irrigation in the southern part of Barber County and the northern portion of Alfalfa County.

Municipal

Municipal water uses include residential, public, commercial, and those industrial uses which are served by organized public water supply systems and are reflected in per capita water use. Combined municipal water use for the two towns of Medicine Lodge and Kiowa is expected to be 1.2 mgd. This is based on the anticipation that approximately 8,320 people will be served by public water supply systems in the two communities and that per capita use will reach 143 gpd by the year 2020. a/

Irrigation

There are approximately 47,000 acres of irrigable land in the Medicine Lodge River basin, most of which lie below the proposed project sites. Only a small portion (about 1,000 acres) of this land is now under irrigation. As indicated from reservoir studies by the Bureau of Reclamation, the proposed Kiowa project can supply the irrigation needs of 8,500 or 10,000 acres of land, depending on the plan of operation used. The larger yield could be achieved if Amber Reservoir is not constructed.

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a/ In accordance with economic and water use projections furnished by the Bureau of Reclamation. 2/

VII. WATER QUALITY CONTROL

General

An important factor in developing adequate water resources of any sector of the country is the problem of waste disposal. Thorough water planning for an area must include not only adequate water supplies for municipal and industrial uses but must also insure that associated wastes are handled without unreasonable damage to water uses. Without this assurance, it has been found that municipal and industrial waste waters, even after a high degree of treatment, may degrade the quality of the receiving stream to the point where fish and wildlife, recreation, water supply, and other uses of the stream will be impaired.

Congress emphasized the importance of water quality control as it applies to our Nation's water resources by the enactment of the Federal Water Pollution Control Act, Public Law 84-660, as amended, (33 U.S.C. 466 et seq.). Under the provisions of this act, in any reservoir being planned by a Federal agency, consideration must be given to the inclusion of storage for regulation of streamflow to control water quality. Storage and release of this water are not to be provided as a substitute for adequate treatment or other methods of controlling wastes at the source.

Municipal, Industrial, and Agricultural Pollution

Principal communities currently discharging wastes to the Medicine Lodge River include the towns of Medicine Lodge and Kiowa. The combined population equivalent (P.E.) [a/] of treated wastes from the two communities now averages about 1,100. [11/] Secondary treatment (with about 70 percent BOD removal) is now provided at both towns. By the year 2020, it is expected that the combined population equivalent of treated wastes from the two communities will average in the neighborhood of 1,500.

Irrigation return flows to the Medicine Lodge River in 1960 (based on information provided by the Bureau of Reclamation) are estimated at 1,300 acre-feet or an average of 2.4 mgd during the six months growing season (April - September). Based on proposed irrigation releases from the Kiowa project (without Amber in operation), it is estimated that between 15,000 to 20,000 acre-feet annually of irrigation return flows would enter the stream and its tributaries in the lower reaches of the basin. Averaged between April and September, this is from 27 to 36 mgd.

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a/ The calculated population which would normally contribute the same amount of BOD per day.

Water Quality Objectives

Evaluation of future stream conditions and the subsequent need for water quality control in the Medicine Lodge River is based on parameters of water quality which are currently available for use. To meet the objectives of this study, the two broad parameters, dissolved oxygen content and dissolved solids, are used. Dissolved oxygen is applied as a measure of unstable pollutants (those constituents which act on or are acted on by the stream environment) as appraised by BOD. It is one of the most meaningful measures of water quality for which predictive techniques can be applied. Dissolved oxygen is a significant factor in maintaining an environment suitable for propagation of fish and wildlife.

Dissolved solids are employed to characterize the effects of stable pollutants (those constituents which are not utilized or reduced by the stream environment), such as chloride and sulfate salts. These constituents are generally not affected in the treatment of municipal wastes. Because of cathartic effects and taste and laxative properties, dissolved solids in excessive amounts are undesirable in waters used for public water supplies.

The following criteria or conditions were assumed in the water quality investigation: (1) The organic loading of untreated municipal waste waters will be 0.3 pound of ultimate BOD per person per day by the year 2020. The effect of organic loading from minor industrial development is included in this value. (2) Sufficient treatment will be provided to remove 85 percent of the BOD from municipal and industrial waste waters. (3) No dissolved solids removal will be achieved by treatment. (4) Uniform mixing of wastes and receiving waters will occur. (5) Water quality control by flow regulation is required when the dissolved oxygen content of the mixed water in the stream falls below 4.0 mg/l. (6) Water quality control of municipal water supplies is desirable when the concentration of dissolved solids and other constituents in finished waters exceed upper limits of the Public Health Service Drinking Water Standards-1962.

Flow Regulation

In determining the amount of water from storage required to preserve water quality in the Medicine Lodge River, allowances are made for flows occurring naturally in the stream. These flows provide a measure of the river's natural waste assimilative capacity and form a basis on which can be established the need for flow regulation or supplemental water quality control releases.

As shown on figure A-1 and discussed in the Appendix, a discharge frequency curve was constructed for the Medicine Lodge River below confluence with Elm Creek from data furnished by the Bureau of Reclamation. The hydrologic conditions that can be expected to recur in the watercourse at this point every 10, 20, and 50 years are shown in table A-1. By comparing these expected monthly flows with those shown in table A-2 (minimum streamflows needed in the river below Medicine Lodge to assimilate total projected waste discharges from both Medicine Lodge and Kiowa in absence of the projects) it is seen that natural streamflow expected to occur in the river at confluence with Elm Creek over a 12-month period and in absence of the projects is more than adequate to assimilate adequately treated future waste discharges from the two communities even at the 50-year drought recurrence interval.

Since the natural flow of the river below confluence with Elm Creek appears adequate to assimilate or biologically stabilize the combined waste loading of both Kiowa and Medicine Lodge, further investigation of streamflow at Kiowa (located about 20 miles downstream from Medicine Lodge) was not considered necessary.

High mineral concentration, particularly sulfates, would presently preclude use of water from the main stem of the Medicine Lodge for domestic and many industrial purposes. All of the principal communities within the vicinity of the Medicine Lodge watershed are now using ground water even where deep wells are necessary. Construction of Kiowa Reservoir, however, is expected to provide a more uniform mineral quality due to the diluting effect of higher quality flood flows. As indicated by limited stream records at Kiowa, dissolved mineral concentrations in the reservoir will make the stored water of marginal quality, exceeding upper limits of the Public Health Service Drinking Water Standards-1962, for finished waters a majority of the time.

As shown by studies of the characteristics and effects of irrigation return flows, buildups in salt concentrations several times greater than the irrigation water may occur. 12/ In view of the relatively high irrigation return flows which may be expected in this area from the proposed Kiowa irrigation project, further deterioration of water quality in the river below Kiowa will likely occur particularly during periods of low flow when irrigation discharge waters will make up the greater part of streamflow. Most of the irrigation return flow will enter the Medicine Lodge River within a short distance above its confluence with the Salt Fork of the Arkansas River. (See figure III-1.)

The Salt Fork is now highly polluted by natural salt pollution from the Great Salt Plains, a depression-like alluvial plain covering about 45 square miles immediately above the Great Salt Plains Reservoir. Dissolved mineral concentrations in the river below the reservoir have exceeded 25,000 mg/l. Investigations are being made, however, to determine the feasibility of eliminating or reducing both manmade and natural salt pollution in the Arkansas River basin which encompasses the Salt Fork and its tributaries. 13/ Due to present pollution levels, much of the water in the main stem of this major river is of little value for many municipal and industrial uses. If measures are undertaken to substantially reduce mineral pollution from the Salt Fork as part of the objective of the Arkansas-Red River Basins Water Quality Conservation Project, the dissolved mineral contribution from the Medicine Lodge tributary will become more significant and may require further study.

Minimum Streamflow Needs with Proposed Projects in Place

If Kiowa Reservoir is constructed, adequately treated waste discharges from the town of Medicine Lodge can be assimilated by the reservoir. Seepage losses for the project (estimated at approximately 5 cfs) will be more than adequate to maintain satisfactory dissolved oxygen levels in the river below Kiowa. In the event these seepage losses do not occur as expected, supplemental releases[a] from the reservoir will be necessary to maintain adequate streamflow (table A-3) assuring satisfactory water quality (DO levels) below the town of Kiowa.

In the absence of Kiowa Reservoir, and with Amber Reservoir in operation, expected natural runoff of the Medicine Lodge River above the Elm Creek confluence appears sufficient to assimilate adequately treated waste discharges from the two communities.

[a] Up to or equal to inflows.

VIII. BENEFITS

Based on information presently available, there is no discernible need for storage of water in the study projects for water quality control purposes in the Medicine Lodge River.

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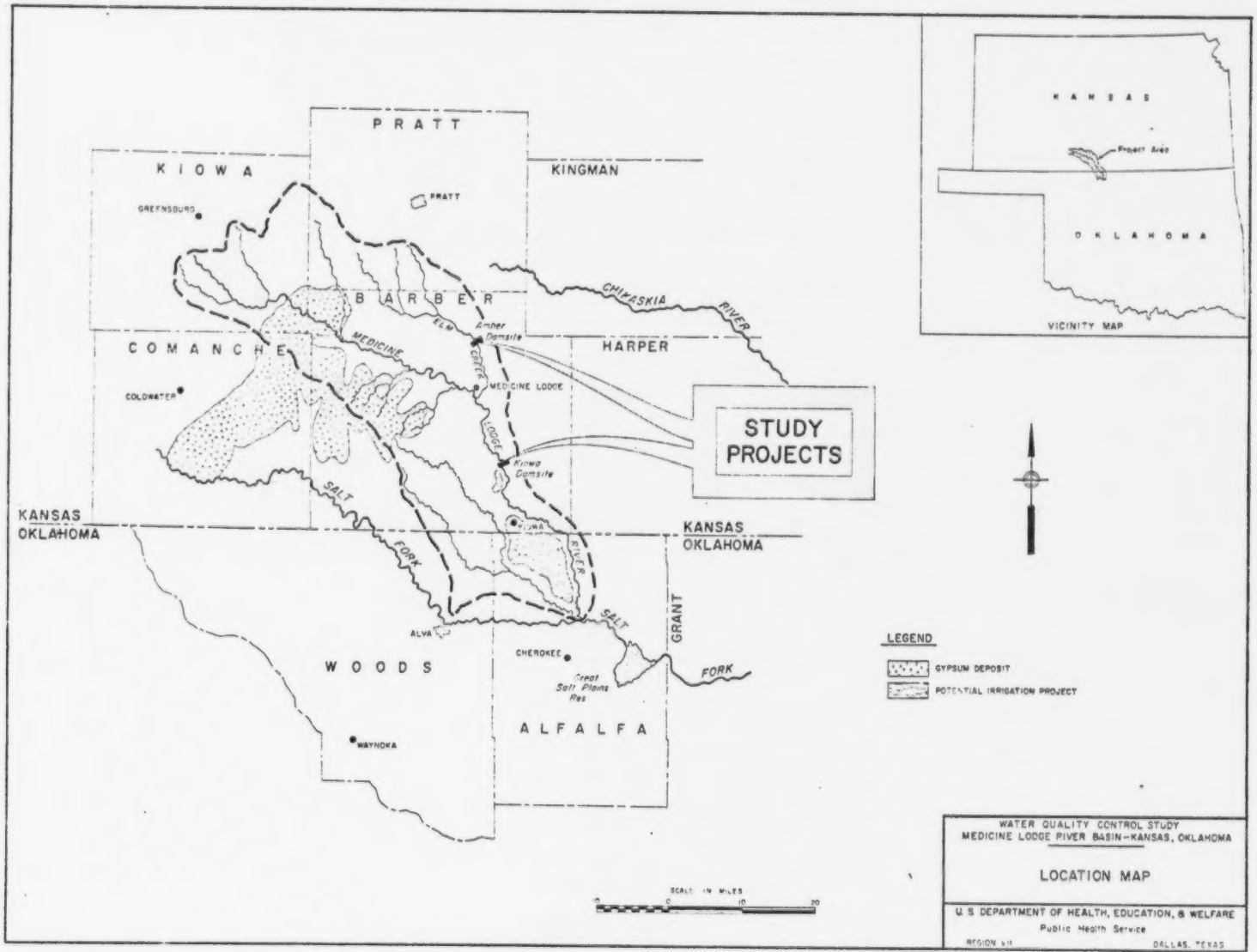
PRATT
KIOWA
KINGMAN
GREENSBURG
PRATT
BARBER
CHIKASKIA RIVER
ELM
Amber Damsite
MEDICINE
CREEK
COMANCHE
HARPER
COLDWATER
MEDICINE LODGE
LODGE
Kiowa Damsite
STUDY PROJECTS
SALT
FORK
KANSAS
OKLAHOMA
KIOWA
RIVER
KANSAS
OKLAHOMA
SALT
FORK
GRANT
ALVA
WOODS
CHEROKEE
Great Salt Plains Res
ALFALFA
WAYNOKA
SCALE IN MILES
0 10 20
KANSAS
Project Area
OKLAHOMA
VICINITY MAP
LEGEND
GYPSUM DEPOSIT
POTENTIAL IRRIGATION PROJECT
WATER QUALITY CONTROL STUDY
MEDICINE LODGE RIVER BASIN—KANSAS, OKLAHOMA
LOCATION MAP
U. S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
Public Health Service
REGION VII
DALLAS, TEXAS

FIGURE III-1

APPENDIX

Water Quality Control

General

In analyzing the needs for water quality control in the Medicine Lodge River basin, consideration was given to (1) supplemental streamflow needs (in excess of natural streamflow) that could be provided through flow regulation by the proposed projects, and (2) reservoir releases or minimum streamflow needs to protect or preserve water quality with the proposed projects in place.

Streamflow Regulation

Supplemental streamflow needed for water quality control purposes may be expressed as annual draft-on-storage or more particularly as the sum of the incremental excesses of needed releases over inflows during a climatic year (April through March).

To assess this need, a frequency curve of estimated natural annual discharges in the Medicine Lodge River below confluence with Elm Creek was constructed using 41 years of data a/ provided by the Bureau of Reclamation. (See figure A-1.) The summary of discharge frequency analysis shown in table A-1 is based upon conditions reflected by this curve.

Minimum monthly flows which will be needed in the Medicine Lodge River by the year 2020 for water quality control are shown in table A-2. These flows represent minimum diluting needs for assimilation of waste discharges to the Medicine Lodge River at Medicine Lodge and at Kiowa.

Comparison of the above flows with expected natural mean monthly flows during drought conditions (table A-1) indicates that streamflows, even at the 50-year drought recurrence interval, are adequate to receive anticipated wastes after adequate treatment, without excessive quality deterioration.

Effects of Proposed Reservoirs

Reservoir operation studies by the Bureau of Reclamation indicate that the entire flow of the streams will be stored for irrigation

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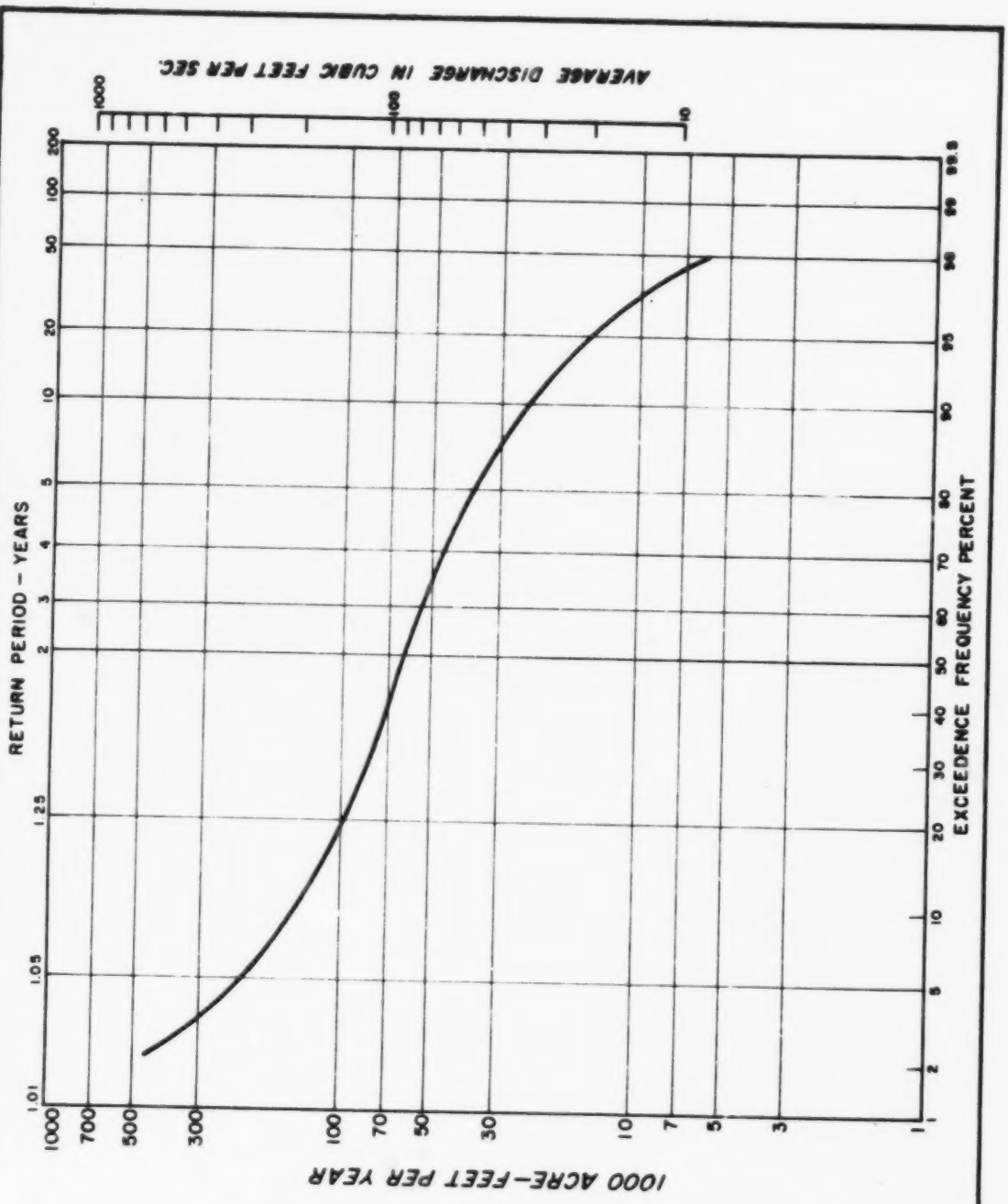
a/ Synthesized data for the period October 1921 to September 1962 based on measured streamflow at Kiowa and modified to show depletions by soil conservation projects. 2/



WATER QUALITY CONTROL STUDY
MEDICINE LODGE RIVER BASIN – KAN., OKLA.

NATURAL ANNUAL DISCHARGE FREQUENCY
MEDICINE LODGE RIVER
BELOW CONFLUENCE WITH ELM CREEK

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
Public Health Service
REGION VII DALLAS, TEXAS

FIGURE A-1

Table A-1

Summary of Discharge-Frequency Analysis
Medicine Lodge River Below Elm Creek
(Flow - cfs)

Month	Percent of Average Annual Discharge	Mean Monthly Discharge for 10, 20, and 50 Year Return Periods or Drought Recurrence Intervals		
		50 Year	20 Year	10 Year
J	57.6	4.4	11.9	19.1
F	61.2	4.7	12.7	20.3
M	98.4	7.5	20.4	32.7
A	132.0	10.0	27.3	43.8
M	182.4	13.9	37.8	60.6
J	163.2	12.4	33.8	54.2
J	100.8	7.7	20.9	33.5
A	94.8	7.2	19.6	31.5
S	92.4	7.0	19.1	30.7
O	85.2	6.5	17.6	28.3
N	85.2	6.5	17.6	28.3
D	46.8	3.6	9.7	15.5
	Average (cfs)	7.6	20.7	33.2
	Total (Acre-feet)	5,500	15,000	24,000

Table A-2

Minimum Flow Required at Medicine Lodge to Maintain Water Quality Below Kiowa (Year 2020)

Month	Mean Flow in CFS Needed to Maintain 4 mg/l of Dissolved Oxygen in the Stream
J	0.6
F	0.6
M	1.2
A	2.3
M	3.4
J	4.3
J	4.8
A	4.8
S	3.4
O	2.3
N	1.2
D	0.8

or water supply purposes during most years. Natural streamflow used as a basis in the foregoing analysis could therefore be reduced to negligible quantities if the projects are constructed.

With these considerations in mind, investigation was made of the effects of proposed reservoirs on the waste assimilative capacity of the Medicine Lodge River which (as shown earlier) would be adequate for maintaining satisfactory dissolved oxygen levels through the year 2020 under natural conditions.

If Kiowa Reservoir is constructed, it was found that adequately treated waste discharges from the community of Medicine Lodge will be assimilated by the reservoir. This would be true if Kiowa is operated with or without Amber Reservoir in place. Further, expected seepage losses (estimated at 5 cfs) from the proposed Kiowa project will be more than adequate to maintain satisfactory dissolved oxygen levels in the stream below the city of Kiowa. (See table A-3.)

Table A-3

Minimum Streamflow Needs
at Kiowa to Maintain Water Quality
(Year 2020)

Month	Mean Flow in CFS Needed to Maintain 4 mg/l of Dissolved Oxygen in the Stream
J	0.3
F	0.3
M	0.6
A	1.1
M	1.6
J	2.0
J	2.3
A	2.3
S	1.6
O	1.1
N	0.6
D	0.5

In the absence of Kiowa Reservoir (with Amber Reservoir operating alone) minimum streamflows of the magnitude shown in table A-2 would be needed to maintain water quality below Medicine Lodge.

As shown by table A-4, the expected natural runoff of the Medicine Lodge River above confluence with Elm Creek (which could be reduced to negligible flow by construction of Amber Reservoir) will exceed these needs. Possible seepage losses from Amber Reservoir (estimated at 1.7 cfs) would further supplement this flow.

Table A-4

Expected Natural Runoff - Medicine Lodge River Above Elm Creek Confluence [a]/
(cfs)

J	8.2
F	8.8
M	14.1
A	18.8
M	26.1
J	23.3
J	14.4
A	13.5
S	13.2
O	12.1
N	12.1
D	6.7

[a]/ Based on 95 percent exceedence interval or drought recurrence interval of once in 20 years.